USB 3.0 ENGINEERING CHANGE NOTICE

ECN# 007

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Title: USB3.0 Efficient ISO and PINGs
Applied to: USB3.0 (11132008)-final

Brief description of the functional changes:

The ECN allows host controllers to provide more information about Isochronous transactions that it performs to a device. It allows the host to inform the device (in a backwards compatible format) how it intends to break the traffic to a particular ISO endpoint in a service interval. This information can be used by a smart device to implement even more efficient power management techniques.

Benefits as a result of the changes:

Benefits described in the brief description of the functional changes detailed above.

An assessment of the impact to the existing revision and systems that currently conform to the USB specification:

No impact to existing hosts, hubs or devices.

An analysis of the hardware implications:

Smart devices and hosts will have to add support for Efficient Isochronous Transactions.

An analysis of the software implications:

None – adding this support requires no software changes.

An analysis of the compliance testing implications:

This change can only be implemented by the scheduler within a host controller. It will not be possible to validate hosts with a specific compliance test. However we will be able to check the behavior of hosts and devices while performing Interoperability tests and ensure that they behave as per specification.

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Actual Changes

(a). Section 8.5, Figure 8-11 and Section 8.6, Figure 8-22, DWORD 2

Add the following bits:
Bits 31-28: NBI/Reserved
Bit 26: DBI/R
Bit 25: WPA/R
Bit 24: SSI

(b). From Text (and location): Table 8-12, Page 8-13

11	2:16	**Reserved.**
1	2:27	**Packets Pending (PP)**. This field can only be set by the Host. If the field is set the host has another packet available for the endpoint identified by the **Endpoint Number and Direction** field. If no endpoints on this device have packets pending, then the device can use this information to aggressively power manage its upstream link, e.g., set the link to a lower power U1 or U2 state.
4	2:28	**Reserved**.

To Text (and location): Table 8-12, Page 8-13

8	2:16	**Reserved.**
1	2:24	**Support Smart Isochronous (SSI).** This field is only valid for ISO endpoints. For OUT endpoints, the **DBI**, **WPA** and **NBI** fields are valid only if this field is set to one and the **Ipf** field is set to zero. In the case of IN endpoints, the host does not set the **Ipf** field and hence it just has to set the SSI field if the host supports smart isochronous scheduling. It informs the device that this host controller supports advanced isochronous scheduling functionality that can be used by the device to drive its link to lower power states in between the times that the host is polling the ISO endpoint in its service interval. In the case the host is transferring data to an OUT endpoint, it is the responsibility of the host controller that it only sets this field to one when the **Ipf** field is set to zero. Device response when both these fields are set to one is undefined. In the case the host is transferring data to an IN endpoint, then if the device responds with a DP that has the **Ipf** field set to one, then it can ignore the value in this field (and other related fields) and simply wait for the host to PING the device again before the endpoint is serviced.
1	2:25	**Will Ping Again (WPA/Reserved).** This field is only valid for ISO endpoints and is only valid when the **SSI** field is set to one. If this field is set to one then the host controller will send a PING TP before it services the endpoint again.
1	2:26	**Data in this Bus Interval is done (DBI/Reserved).** This field is only valid for ISO endpoints and is only valid when the **SSI** field is set to one. If this field is set to one then the host controller is done performing transactions to this endpoint in the current bus interval. Note: WPA has a higher priority than this field. When a host sets the WPA field, the device can safely ignore the value in this field as the host will PING the device before resuming transactions to this endpoint.
1	2:27	**Packets Pending (PP)**. This field can only be set by the Host. If the field is set the host has another packet available for the endpoint identified by the **Endpoint Number and Direction** field. If no endpoints on this device have packets pending, then the device can use this information to aggressively power manage its upstream link, e.g., set the link to a lower power U1 or U2 state.
4	2:28	**Number of Bus Intervals (NBI/Reserved).** This field is only valid for ISO endpoints and is only valid when the **SSI** field is set to one, the **WPA** field is set to zero and the **DBI** field is set to one. The value in this field informs the device the number of bus intervals after which the host controller will perform transactions to the endpoint again. The value in this filed indicates to the endpoint that the host controller will service the endpoint in the bus interval with a value equal to (current bus interval + value in **NBI** field + 1).

(c). Add the following text to end of Section 8.12.1.6, Page 8-66

The **SSI**, **WPA**, **DBI** and **NBI** fields (described in Table 8-12) are provided in addition to the **lpf** to give devices more information about when the host plans to transfer isochronous data thus allowing them to more aggressively manage their upstream link. The **DBI** is used to tell the device that the host has no more data to transfer during the current bus interval. The **WPA** field, when set to one, informs the device that the host will send a PING TP to the device before it initiates a data transfer on the endpoint again.
The **NBI** value provides the device additional information (when **DBI** is set to one and **WPA** is set to zero) that it may use to more aggressively manage its upstream port. The value is used to determine the bus interval number (see Table 8-12) that the host will initiate another data transfer on the endpoint. In this case, the host will not be required to send a PING TP before it resumes transfers to the endpoint; it is the devices responsibility to manage its upstream port's link accordingly.

Note that the SSI and related fields are only valid and may only be used by a host to inform a device about the manner in which it will service a particular isochronous endpoint on a device within a service interval. A host is always required to send a PING and wait for a PING_RESPONSE before servicing an isochronous endpoint before the start of each service interval.

(d). From Text (and location): Section 4.3.1, Page 4-2

- USB 2.0 offers no mechanism for isochronous capable devices to enter the low power USB bus state between service intervals. SuperSpeed allows isochronous capable devices to autonomously enter low-power link states between service intervals. A SuperSpeed host may transmit a PING packet to the targeted isochronous device before service interval to allow time for the path to transition back to the active power state before initiating the isochronous transfer.

To Text (and location): Section 4.3.1, Page 4-2

- USB 2.0 offers no mechanism for isochronous capable devices to enter the low power USB bus state between service intervals. SuperSpeed allows isochronous capable devices to autonomously enter low-power link states between service intervals. A SuperSpeed host shall transmit a PING packet to the targeted isochronous device before the service interval to allow time for the path to transition back to the active power state before initiating the isochronous transaction.

(e). From Text (and location): Section 4.4.8, Page 4-15

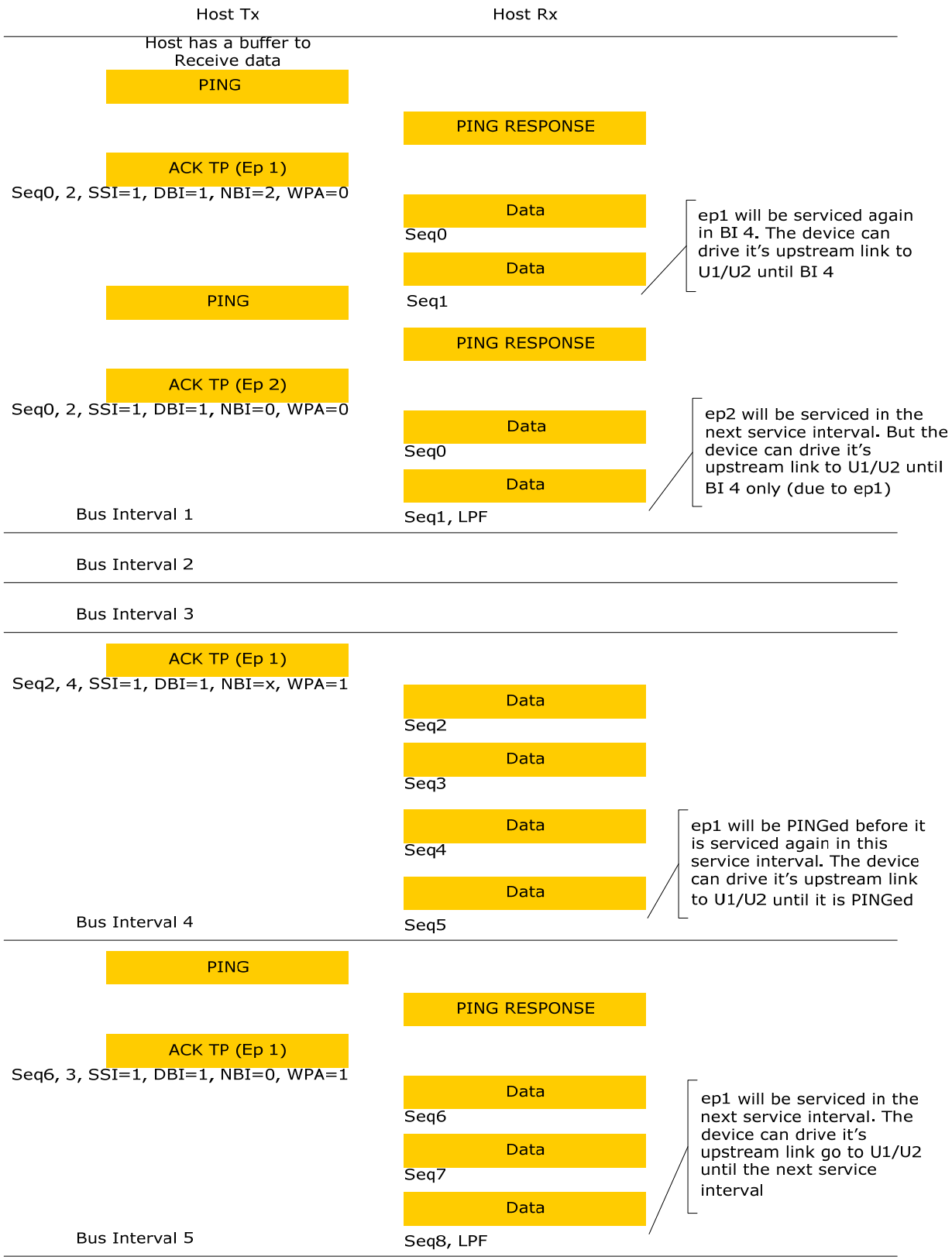
SuperSpeed power management may interfere with isochronous transfers whenever an isochronous transfer needs to traverse a non-active link. The resultant delay could result in the data not arriving within the service interval. To overcome this, SuperSpeed defines a PING and PING_RESPONSE mechanism (refer to Section 8.5.7). Before initiating an isochronous transfer the host may send a PING packet to the device. The device responds with a PING_RESPONSE packet that tells the host that all the links in the path to the device are in the active state.

To Text (and location): Section 4.3.1, Page 4-15

SuperSpeed power management may interfere with isochronous transactions whenever an isochronous transaction needs to traverse a non-active link. The resultant delay could result in the data not arriving within the service interval. To overcome this, SuperSpeed defines a PING and PING_RESPONSE mechanism (refer to Section 8.5.7). Before initiating an isochronous transaction the host shall send a PING packet to the device. The device responds with a PING_RESPONSE packet that tells the host that all the links in the path to the device are in the active state.

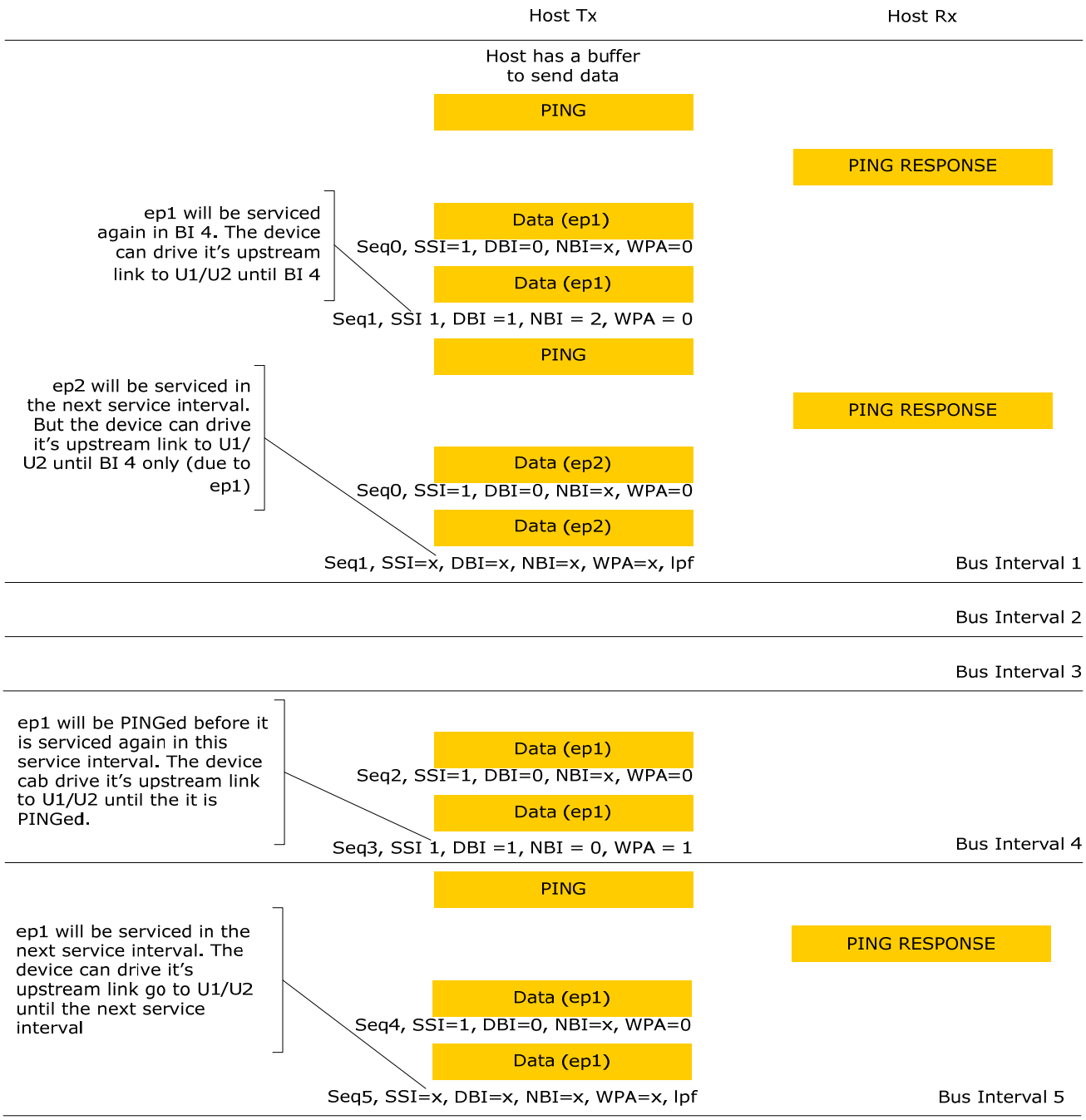
Add the following diagrams in 8.12.6 after figure 8-51

Figure 8-52 and Figure 8-53 show sample isochronous IN and OUT transactions with smart Isochronous scheduling to endpoints that has service interval of 8. In the isochronous IN example below the host is only sending one ACK TP with the SSI and DBI field set to non=zero values when asking for data from the endpoint. It should be noted a host may send multiple ACK TPs with only the last ACK TP in the current bus interval having the SSI and DBI fields set to non-zero values.



Note: ep1/ep2 service interval 8 = Bus Intervals, each expected to return 10 packets each

Figure 8-53 Example Smart Isochronous IN Transaction



Note: ep1/ep2 service interval 8 = Bus Intervals, each expected to return 10 packets each

Figure 8-53 Example Smart Isochronous OUT Transaction